THE CLAIMS

What is claimed is:

1. A scrubbing system for the abatement of a gas component in a gas stream containing same, said scrubbing system comprising a gas/liquid contacting chamber including means for introducing to said contacting chamber the gas stream and a scrubbing liquid for gas/liquid contacting therein, and additionally at least one of the features of:

(a) a chemical injector for introducing a chemical reagent for contact with the gas component to remove same from the gas stream in said gas/liquid contacting, optionally in combination with a back pressure inducing device arranged to at least partially reduce foaming in the scrubbing system incident to chemical reagent injection;

(b) an inlet arranged for introduction to the gas stream flowed therethrough of a gas to enhance removal of silane from the gas stream when present therein;

(c) a second gas/liquid contacting chamber receiving a treated gas stream from the first gas/liquid contacting chamber and including means for introducing to said second contacting chamber a second scrubbing liquid for gas/liquid contacting therein, wherein the first gas/liquid contacting chamber is constructed and arranged for cocurrent flow of the gas stream and scrubbing liquid and wherein the second gas/liquid contacting chamber is constructed and arranged for countercurrent flow of the gas stream and the second scrubbing liquid;

(d) an antifoam agent injector for introducing to scrubbing liquid for said gas/liquid contacting a foam-suppressing antifoam agent, to suppress foam production in the scrubbing chamber, optionally in combination with a back pressure inducing device,

arranged to at least partially reduce foaming in the scrubbing system incident to antifoam agent injection;

(e) means for suppressing deposition of calcium carbonate from scrubbing liquid containing calcium, said suppressing means being selected from the group consisting of:

(1) a magnetization zone for imposing a magnetic field on scrubbing liquid prior to use thereof in the contacting chamber;

(2) means for adjusting the pH of the scrubbing liquid to maintain pH thereof below 8.5;

(3) a lime-soda ash bed arranged for flow of the scrubbing liquid therethrough prior to use of the scrubbing liquid in the contacting chamber; and

(4) a precipitator for precipitating the calcium content of the scrubbing liquid prior to use of the scrubbing liquid in the contacting chamber; and

(f) means for suppressing solids formation in a passage of the scrubbing system, selected from the group consisting of means for flowing a purge gas through the passage to suppress solids formation therein, and means for heating the passage to suppress solids formation therein; and

(g) means for abating silane from the gas stream when present therein in combination with ammonia, such means being selected from the group consisting of:

(2) means for heating the gas stream prior to introduction of same to the scrubbing system; and

(2) a second gas/liquid contacting chamber according to (c) hereof, and means for introducing clean dry air or other oxygen-containing gas to the treated gas stream from the first gas/liquid contacting chamber prior to introduction thereof to the second gas/liquid contacting chamber.

2. A scrubbing system including an inlet structure for introducing to a scrubbing apparatus a gas stream containing a silane component by flow of the gas stream through the inlet structure, said inlet structure including means for introducing to the gas stream flowed therethrough a gas to enhance removal of the silane component in the scrubbing system.

3. The scrubbing system according to claim 2, wherein said inlet structure is coupled to a source of oxygen-containing gas.

4. The scrubbing system according to claim 2, wherein the inlet structure is coupled to a source of nitrogen gas.

5. A scrubbing system including an inlet structure for introducing to a scrubbing apparatus a gas stream containing a silane component by flow of the gas stream through the inlet structure, said inlet structure including means for introducing to the gas stream flowed therethrough a gas to enhance removal of the silane component in the scrubbing system, wherein said gas introducing means comprise (i) an upper inlet portion including an annular gas introduction passage including a gas-permeable wall bounding a gas flow passage of the upper inlet portion, and through which said silane-removal-enhancing gas may be flowed, (ii) a lower inlet portion including an annular overflow liquid reservoir with an inner wall having an inner wall surface bounding a gas flow passage through the lower inlet portion of the inlet structure producing on overflow a falling film of liquid on the inner wall surface to flush such inner wall surface of solids and solids-forming components of the gas stream and (iii) a gas inlet tube extending into the gas flow passage and terminating at a lower end in one of the upper inlet and lower inlet portions of the gas introducing means;

wherein said gas introducing means is constructed and arranged to introduce silane-containing gas from a source thereof to the scrubbing apparatus.

6. A scrubbing system for treatment of an effluent gas including acid gas components and water-scrubbable components other than acid gas components, said scrubbing system comprising:

a first scrubber unit for scrubbing the effluent gas with an aqueous scrubbing liquid to remove the acid gas components thereof, said first scrubber unit being constructed and arranged for co-current flow contacting of the aqueous scrubbing liquid and effluent gas with one another to yield effluent gas reduced in acid gas components, water-scrubbable components other than acid gas components and water-reactive gases;

a second scrubber unit for scrubbing the effluent gas with a second aqueous scrubbing liquid to remove residual acid gases, residual water-scrubbable components other than acid gas components and residual water-reactive gases, said second scrubber unit being constructed and arranged for counter-current flow contacting of the second aqueous scrubbing liquid and effluent gas with one another to yield effluent gas further reduced in acid gas components, water-scrubbable components other than acid gas components and water-reactive gases; and

means for flowing the effluent gas reduced in acid gas components, water-scrubbable components other than acid gas components and water-reactive gases, from the first scrubber unit to the second scrubber unit.

7. The scrubbing system according to claim 6, wherein the volume of said second scrubber unit is substantially smaller than the volume of said first scrubber unit.

8. A scrubbing system for treatment of an effluent gas to remove water scrubbable components of the effluent gas, by contacting the effluent gas with an aqueous scrubbing medium in a gas/liquid contacting chamber, comprising means for suppressing deposition of calcium carbonate from aqueous scrubbing medium containing calcium, said suppressing means being selected from the group consisting of:

(1) a magnetization zone for imposing a magnetic field on scrubbing liquid prior to use thereof in the contacting chamber;

(2) means for adjusting the pH of the scrubbing liquid to maintain pH thereof below 8.5;

(3) a lime-soda ash bed arranged for flow of the scrubbing liquid therethrough prior to use of the scrubbing liquid in the contacting chamber.

9. A scrubbing system for treatment of an effluent gas to remove water scrubbable components of the effluent gas, by contacting the effluent gas with an aqueous scrubbing medium in a gas/liquid contacting chamber, said system comprising a precipitator for precipitating the calcium content of the aqueous scrubbing medium prior to use of the aqueous scrubbing medium in the contacting chamber, said precipitator comprising a chamber for contacting the aqueous scrubbing medium with a chemical agent effective to precipitate the calcium content of the aqueous scrubbing medium and means for conveying the chemical agent to the contacting chamber.

10. A scrubbing system for treatment of an effluent gas to remove water scrubbable components of the effluent gas, by contacting the effluent gas with an aqueous scrubbing medium in a gas/liquid contacting chamber including a chamber wall enclosing an interior volume of said contacting chamber, said contacting chamber including means for redirecting fluid flow along the wall into an inner region of the interior volume of the chamber.

11. A gas/liquid contacting article, for removable installation in a scrubber vessel having means for introducing a gas and liquid to an interior volume of the scrubber vessel for gas/liquid contacting therein, said packing medium assembly comprising a foraminous bag and a mass of packing elements contained in said bag.

12. The gas/liquid contacting article according to claim 11, wherein the bag is formed of a polymeric mesh.

13. The gas/liquid contacting article according to claim 11, further comprising a manually operable closure element for the bag.

14. An apparatus for abating fluorocompound in an effluent gas stream containing same, comprising

a water scrubber unit for gas/liquid contacting;

means for introducing the fluorocompound-containing effluent gas stream to the water scrubber unit;

means for discharging a fluorocompound-reduced effluent gas stream from said water scrubber unit; and

a source of a reducing agent, operatively coupled with the water scrubbing unit and arranged for introducing reducing agent to the water scrubber unit during operation thereof.

15. The apparatus according to claim 14, wherein the source of reducing agent comprises a means for injecting the reducing agent into the water scrubber unit.

16. The apparatus according to claim 14, further comprising a means for monitoring fluorocompound concentration in the fluorocompound-containing effluent gas stream, and in response thereto adjusting the introduction of the reducing agent to the water scrubber unit.

17. A semiconductor manufacturing facility, comprising:

a semiconductor manufacturing process unit producing an effluent gas stream containing a fluorocompound; and

an apparatus for abating fluorocompound in said effluent gas stream, comprising:

a water scrubber unit for gas/liquid contacting;

means for introducing the fluorocompound-containing effluent gas stream to the water scrubber unit;

means for discharging a fluorocompound-reduced effluent gas stream from said water scrubber unit; and

a source of a reducing agent, operatively coupled with the water scrubbing unit and arranged for introducing reducing agent to the water scrubber unit during operation thereof.

18. The semiconductor manufacturing facility according to claim 17, wherein the semiconductor manufacturing process unit comprises a process unit selected from the group consisting of plasma reaction chambers, chemical vapor deposition chambers, vaporizers, epitaxial growth chambers, and etching tools.

19. The semiconductor manufacturing facility according to claim 17, wherein the source of reducing agent comprises a means for injecting the reducing agent into the water scrubber unit.

20. The semiconductor manufacturing facility according to claim 17, further comprising a means for monitoring fluorocompound concentration in the fluorocompound-containing effluent gas stream, and in response thereto adjusting the introduction of the reducing agent to the water scrubber unit.

21. A scrubbing process for the abatement of a gas component in a gas stream containing same, said scrubbing process comprising introducing the gas stream and a scrubbing liquid to a gas/liquid contacting chamber and effecting gas/liquid contacting therein, wherein said process additionally at least one of the steps of:

(a) introducing a chemical reagent for contact with the gas component to remove same from the gas stream in said gas/liquid contacting;

(b) introducing to the gas stream prior to entry thereof into the contacting chamber, a gas to enhance removal of silane from the gas stream when present therein;

(c) flowing the effluent gas from the contacting chamber to a second gas/liquid contacting chamber and introducing to said second contacting chamber a second scrubbing liquid for gas/liquid contacting therein, wherein the first gas/liquid contacting in the first chamber comprises cocurrent flow of the gas stream and scrubbing liquid and wherein the second gas/liquid contacting in the second contacting chamber comprises countercurrent flow of the gas stream and the second scrubbing liquid through the second contacting chamber;

(d) introducing an antifoam agent to scrubbing liquid for said gas/liquid contacting, to suppress foam production in the contacting chamber;

(e) suppressing deposition of calcium carbonate from scrubbing liquid containing calcium, including a step selected from the group consisting of:

(1) imposing a magnetic field on scrubbing liquid prior to use thereof in the contacting chamber;

(2) adjusting the pH of the scrubbing liquid to maintain pH thereof below 8.5;

(3) flowing the scrubbing liquid through a lime-soda ash bed prior to use of the scrubbing liquid in the contacting chamber; and

(4) precipitating the calcium content of the scrubbing liquid prior to use of the scrubbing liquid in the contacting chamber; and

(f) suppressing solids formation in a passage of the scrubbing system, said passage comprising a conduit to a pressure sensing device, including a step selected from the group consisting of flowing a purge gas through the passage to suppress solids formation therein, and heating the passage to suppress solids formation therein.

22. A process for treating a gas stream containing a silane component to abate components of the gas stream, said process comprising scrubbing the gas stream with an aqueous scrubbing medium, and contacting the gas stream prior to scrubbing with a gas to enhance removal of the silane component in the scrubbing step.

23. The process according to claim 22, wherein said gas comprises an oxygen-containing gas.

24. The process according to claim 22, wherein said gas comprises nitrogen gas.

25. A scrubbing process wherein a gas to be scrubbed is flowed through an inlet structure to a scrubbing apparatus, and the gas contains a silane component, said process comprising introducing to the gas flowed through the inlet structure a gas to enhance removal of the silane component in the scrubbing apparatus, wherein said gas inlet structure comprises (i) an upper inlet portion including an annular gas introduction passage including a gas-permeable wall bounding a gas flow passage of the upper inlet portion, and through which said silane-removal-enhancing gas may be flowed, (ii) a lower inlet portion including an annular overflow liquid reservoir with an inner wall having an inner wall surface bounding a gas flow passage through the lower inlet portion of the inlet structure producing on overflow a falling film of liquid on the inner wall surface to flush such inner wall surface of solids and solids-forming components of the gas stream and (iii) a gas inlet tube extending into the gas flow passage and terminating at a lower end in one of the upper inlet and lower inlet portions of the gas inlet structure;

wherein said gas inlet structure is constructed and arranged to introduce silane-containing gas from a source thereof to the scrubbing apparatus.

26. A scrubbing process for treatment of an effluent gas including acid gas components and water-scrubbable components other than acid gas components, said process comprising:

scrubbing the effluent gas with an aqueous scrubbing liquid in a first scrubbing zone to remove the acid gas components of the effluent gas, with co-current flow contacting of the aqueous scrubbing liquid and effluent gas with one another to yield effluent gas reduced in acid gas components;

scrubbing the effluent gas with a second aqueous scrubbing liquid in a second scrubbing zone to remove water-scrubbable components other than acid gas components from the effluent gas, with counter-current flow contacting of the second aqueous scrubbing liquid and effluent gas with one another to yield effluent gas reduced in acid gas components and water-scrubbable components other than acid gas components; and

flowing the effluent gas reduced in acid gas components from the first scrubber unit to the second scrubber unit. {Joe Sweeney comments: Note that both acid gas components and water-scrubbable components other than acid gas components would be reduced in concentration after passing through the co-current flow contacting stage. In addition, water reactive gases would be reduced in concentration in the co-current stage. Acid gas components and water-soluble components are reduced in the co-current stage to concentrations approaching those corresponding to the respective equilibrium values of the acid gas components and water-soluble components in the aqueous scrubbing liquid.}

27. The process according to claim 26, wherein the volume of said second scrubbing zone is substantially smaller than the volume of said first scrubbing zone.

28. A scrubbing process for treatment of an effluent gas to remove water scrubbable components of the effluent gas, by contacting the effluent gas with an aqueous scrubbing medium in a gas/liquid contacting zone, comprising suppressing deposition of calcium carbonate from aqueous scrubbing medium containing calcium, including a suppressing step selected from the group consisting of:

(1) imposing a magnetic field on scrubbing liquid prior to use thereof in the contacting zone;

(2) adjusting the pH of the scrubbing liquid to maintain pH thereof below 8.5;

(3) flowing the scrubbing liquid through a lime-soda ash bed prior to use of the scrubbing liquid in the contacting chamber.

29. A scrubbing process for treatment of an effluent gas to remove water scrubbable components of the effluent gas, by contacting the effluent gas with an aqueous scrubbing medium in a gas/liquid contacting chamber, said process comprising precipitating the calcium content of the aqueous scrubbing medium prior to use of the aqueous scrubbing medium in the contacting chamber, including a step of contacting the aqueous scrubbing medium with a chemical agent effective to precipitate the calcium content of the aqueous scrubbing medium.

30. A scrubbing process for treatment of an effluent gas to remove water scrubbable components of the effluent gas, by contacting the effluent gas with an aqueous scrubbing medium in a gas/liquid contacting chamber including a chamber wall enclosing an interior volume of said contacting chamber, said contacting comprising redirecting fluid flow along the wall into an inner region of the interior volume of the chamber.

31. A gas/liquid contacting process, comprising suppressing wall effects in a scrubber vessel containing a packing material, by at least one step selected from the group consisting of:

removably installing in the scrubber vessel a packing medium assembly comprising a foraminous containment structure and a mass of packing elements contained therein, and flowing a gas stream and a scrubbing liquid through the foraminous containment structure for gas/liquid contacting on the packing elements; and

disrupting flow at an interior wall surface of the scrubber vessel by a physical structure augmentation of the wall surface.

32. The process according to claim 31, wherein the bag is formed of a polymeric mesh.

33. The process according to claim 31, wherein the bag comprises a manually operable closure element.

34. A process for abating fluorocompound in a gas stream containing same, comprising scrubbing the gas stream with an aqueous medium in the presence of a reducing agent.

35. The process according to claim 34, wherein the reducing agent includes at least one compound from the group consisting of sodium thiosulfate, ammonium hydroxide and potassium iodide.

36. The process according to claim 34, wherein the reducing agent includes sodium thiosulfate.

37. The process according to claim 34, wherein the reducing agent includes ammonium hydroxide.

38. The process according to claim 34, wherein the reducing agent includes potassium iodide.

39. The process according to claim 34, wherein the reducing agent is injected into the aqueous medium during the scrubbing.

40. The process according to claim 34, wherein the fluorocompound comprises fluorine gas.

41. The process according to claim 34, wherein the fluorocompound comprises a gaseous fluoride compound.

42. The process according to claim 34, wherein the fluorocompound-containing gas stream comprises effluent of a semiconductor manufacturing process.

43. The process according to claim 34, wherein the fluorocompound-containing gas stream comprises effluent from a plasma reactor cleaning operation in a semiconductor manufacturing facility.

44. The process according to claim 34, further comprising monitoring a process condition of the gas stream and introducing the reducing agent in an amount dependent on said process condition.

45. The process according to claim 44, wherein the process condition of the gas stream is pH.

46. The process according to claim 34, wherein the process condition of the gas stream is fluorocompound concentration therein.

47. A process for abatement of fluorocompound from an effluent stream containing same, comprising contacting the gas stream with an aqueous medium in the presence of a reducing agent that is reactive with the fluorocompound to reduce same in the effluent stream without formation of OF_2.

48. The process of claim 47, wherein the reducing agent is selected from the group consisting of potassium hydroxide and sodium hydroxide.

49. A process for abatement of silane from an effluent stream containing same, comprising scrubbing the effluent stream with an aqueous medium, and introducing clean dry air to at least one of the effluent stream and the aqueous medium, in a

sufficient amount and at sufficient rate to reduce silane concentration in the effluent stream.

50. An effluent abatement scrubbing system comprising a water scrubber for scrubbing of an effluent gas, said system being constructed and arranged for performing at least one of the functions selected from the group consisting of:

(1) water scrubbing of effluent gas with addition or injection of chemical reducing reagents;

(2) water scrubbing of effluent gas containing silane, wherein clean dry air is introduced to the effluent gas or scrubbing liquid;

(3) utilizing a two-stage scrubbing system including an equilibrium scrubbing column and a polishing mass transfer column, to decrease required make-up water for scrubbing while simultaneously maintaining or increasing scrubbing efficiency relative to a single-stage scrubbing unit;

(4) adding clean dry air to effluent gas discharged from the equilibrium scrubbing column of (3), prior to its introduction to the polishing mass transfer scrubbing column, to abate silane when present with ammonia in the effluent gas stream;

(5) utilizing in a two-stage scrubbing system of (3) a foraminous containment structure containing bed packing as an insert in the polishing mass transfer column;

(6) contacting effluent gas in the scrubbing system with OF_2 reducing agents;

(7) controlling foaming in the scrubbing system by chemical antifoam agents and/or orifice restriction of flow of scrubbing liquid;

(8) preventing $CaCO_3$ buildup in the scrubbing system by one or more of the following:

(a) magnetization of make-up water used for scrubbing;

(b) control of the pH of the make-up water;

(c) soda ash-lime softening of the make-up water; and

(d) precipitation or flocculation treatment of the make-up water;

(9) suppressing clogging of a photohelic port including a photohelic sensing line in the scrubbing system, by passing a stream of purge gas through the photohelic sensing line, wherein the photohelic sensing line may optionally be heated; and

(10) heating an inlet structure used in the scrubbing system to introduce effluent gas to a scrubbing zone.

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